PCB Design Introduction and Demo

UNC CHARLOTTE

The WILLIAM STATES LEE COLLEGE *of* ENGINEERING

February 16th 2016

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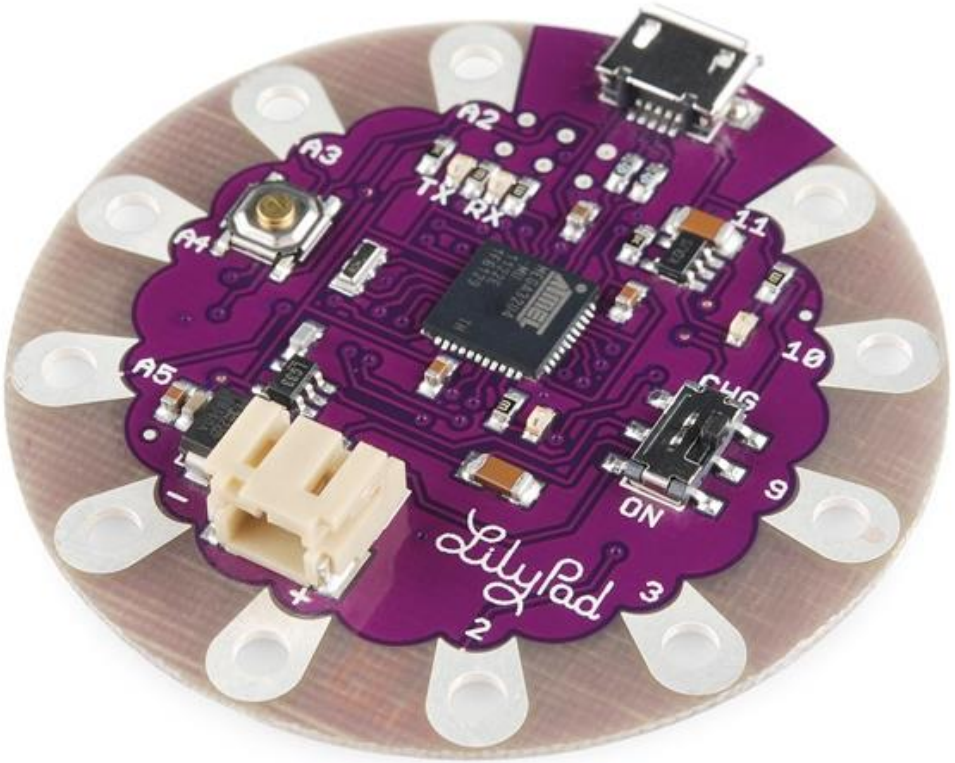
Agenda

- What is a Printed Circuit Board (PCB)?
- Why do Embedded Engineers need them?
- Basic Terminology Specific to PCBs
- Design Consideration / Constraints
  - Size
  - Cost
  - Power Requirements
- PCB Soldering Techniques
- Pitfalls in PCB Design
- Demo Time!
- Additional Resources (How to get a board made)
- References

What is a Printed Circuit Board (PCB)?

- A printed Circuit Board or PCB is simply a copper etched board that contains traces to varies components



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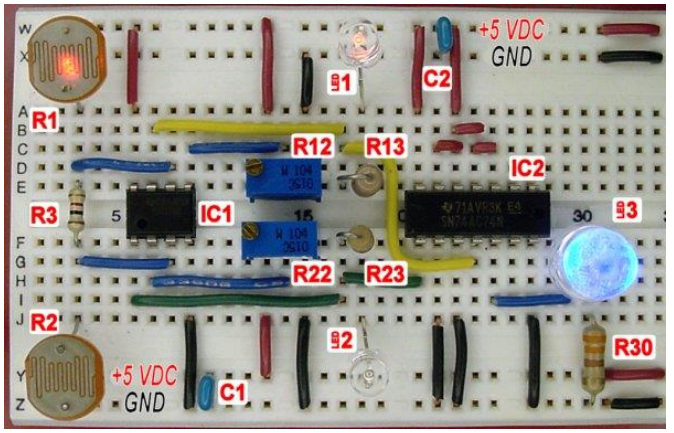
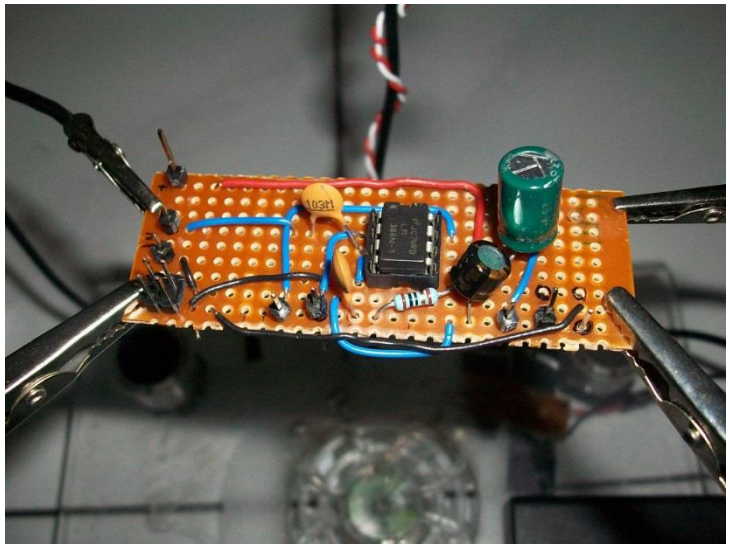
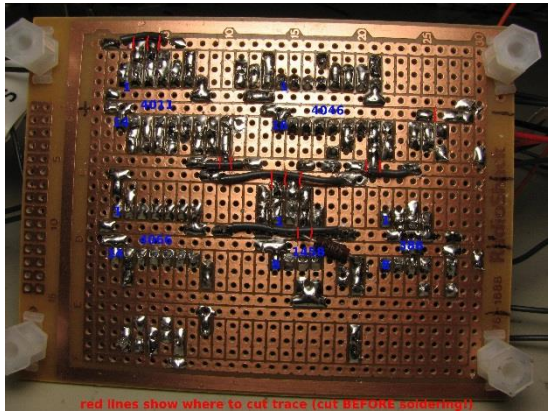
Why Do Embedded Engineers Need a PCB?

- As an embedded engineer you will eventually be “embedded” your designed device into its final location.
- Examples include:
  - Bridge Monitoring
  - Cell Phone







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Why Do Embedded Engineers Need a PCB?

Smaller Manufacturing makes for smaller devices

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Why Do Embedded Engineers Need a PCB?

Making Items smaller!

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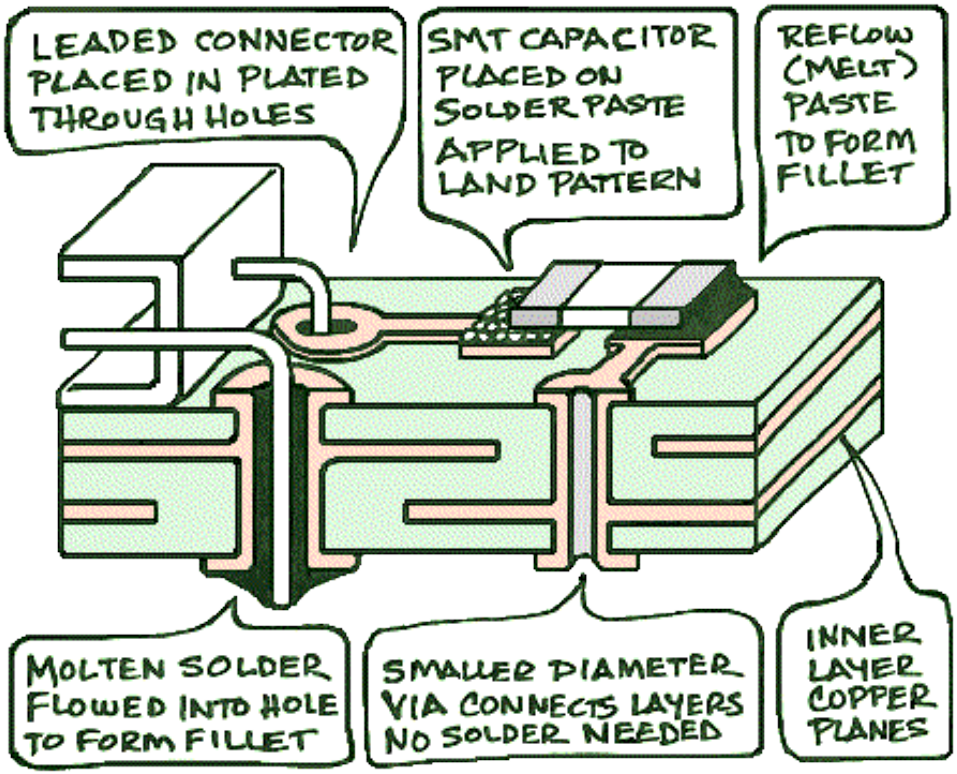
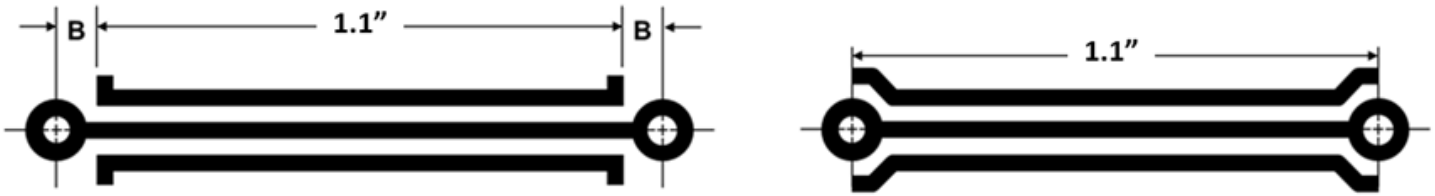
Terminology (Layers)

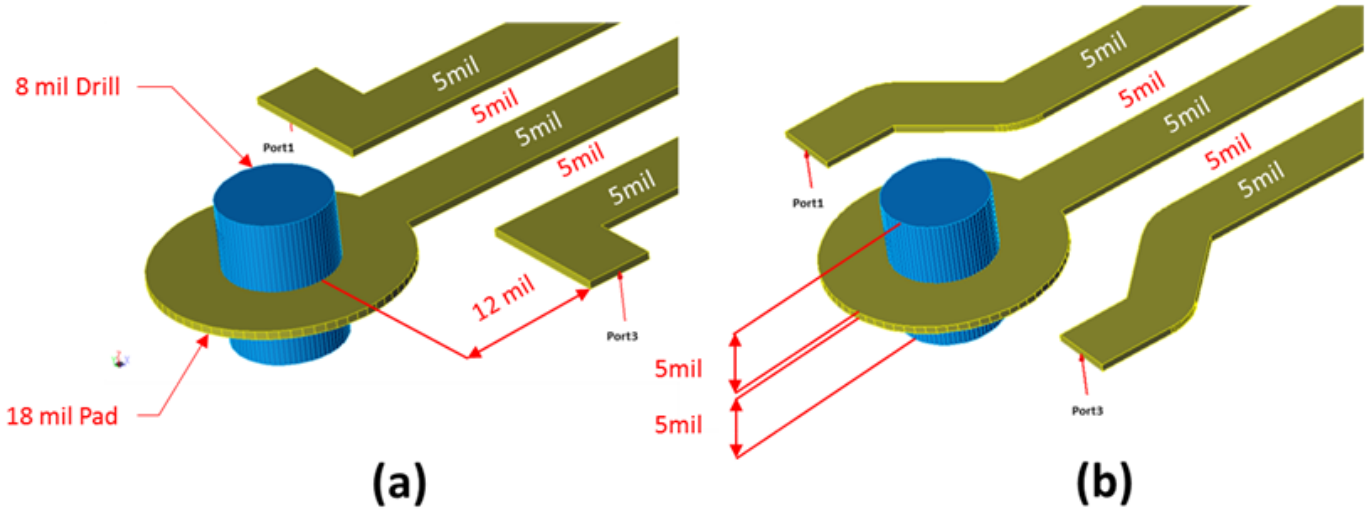
- Many boards are multilayer board to accommodate all the components needed for the board to be compact and function in its intended environment



Terminology (Traces / Trace Width)

- Trace width and trace spacingg needs to be calculated depending on your current requirements and size constraints.





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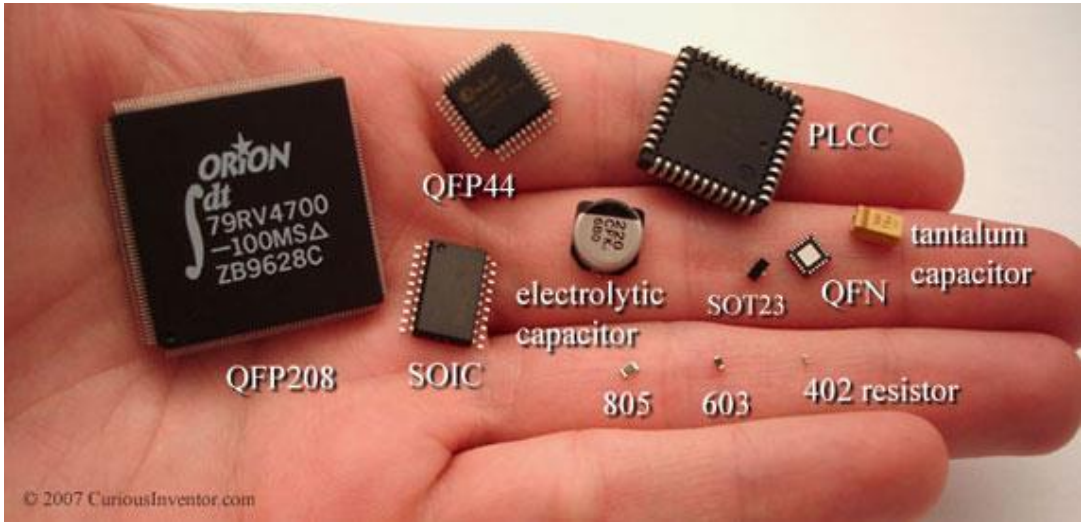
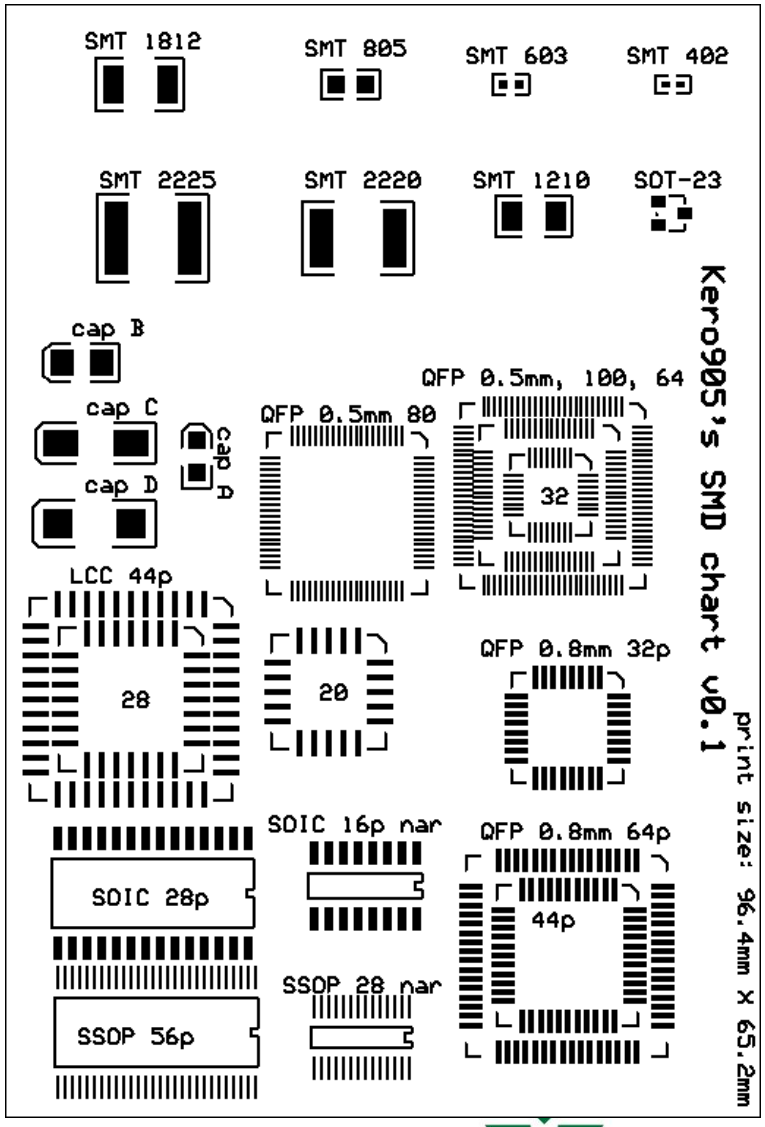
Terminology (Part Footprints)

- All THT and SMT parts have an accosted footprint with the device. Most manufactures / distributors will offer a large variety of package sizes for each part.





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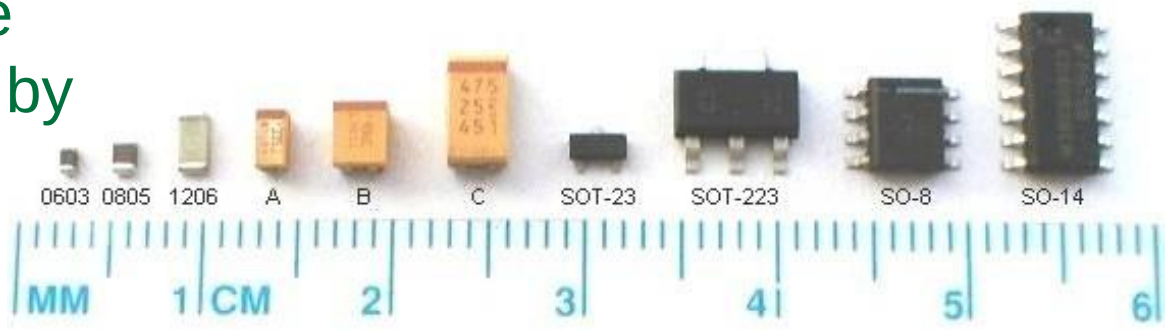
Terminology (Part Package Size)

- When designing a PCB with tight size constraints you will need to consider the different package size for your parts that you will be using

- *NOTE* that the smaller the package size the harder it is to solder by hand (sometimes impossible)

SURFACE MOUNT PACKAGE SIZES

Package type	Size in inches	Size in mm
0201	0.024" × 0.012"	0.6 mm × 0.3 mm
0402	0.04" × 0.02"	1.0 mm × 0.5 mm
0603	0.063" × 0.031"	1.6 mm × 0.8 mm
0805	0.08" × 0.05"	2.0 mm × 1.25 mm
1206	0.126" × 0.063"	3.2 mm × 1.6 mm
1210	0.12" × 0.10"	3.2 mm × 2.6 mm
2020	0.20" × 0.20"	5.08 mm × 5.08 mm
2512	0.25" × 0.12"	6.35 mm × 3.0 mm



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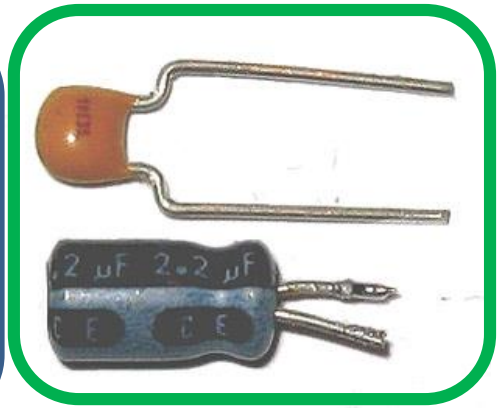
Terminology (Through Hole, Surface Mount)

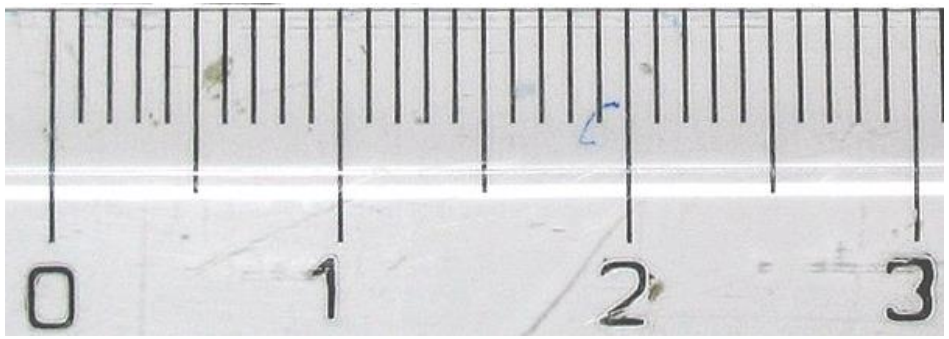
- There are two basic component types
  - Through Hole
  - Surface Mount

- Depending on your application you may use only SMT, only THT or a combo of the two

SMT
(Surface Mount Technology)



THT
(Through Hole Technology)



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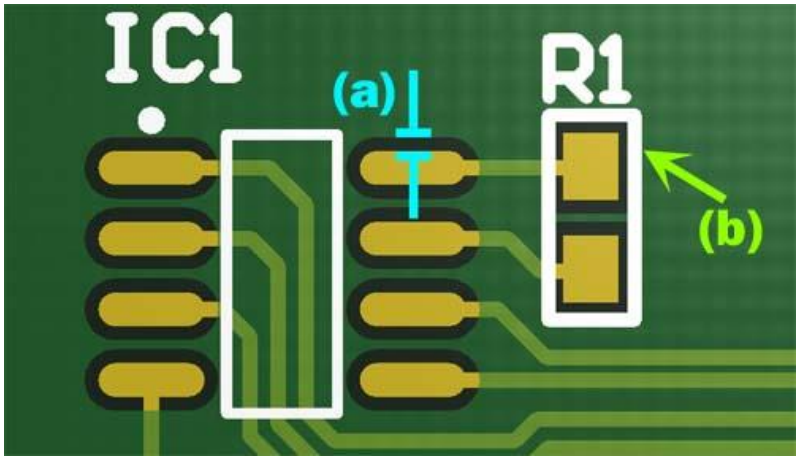
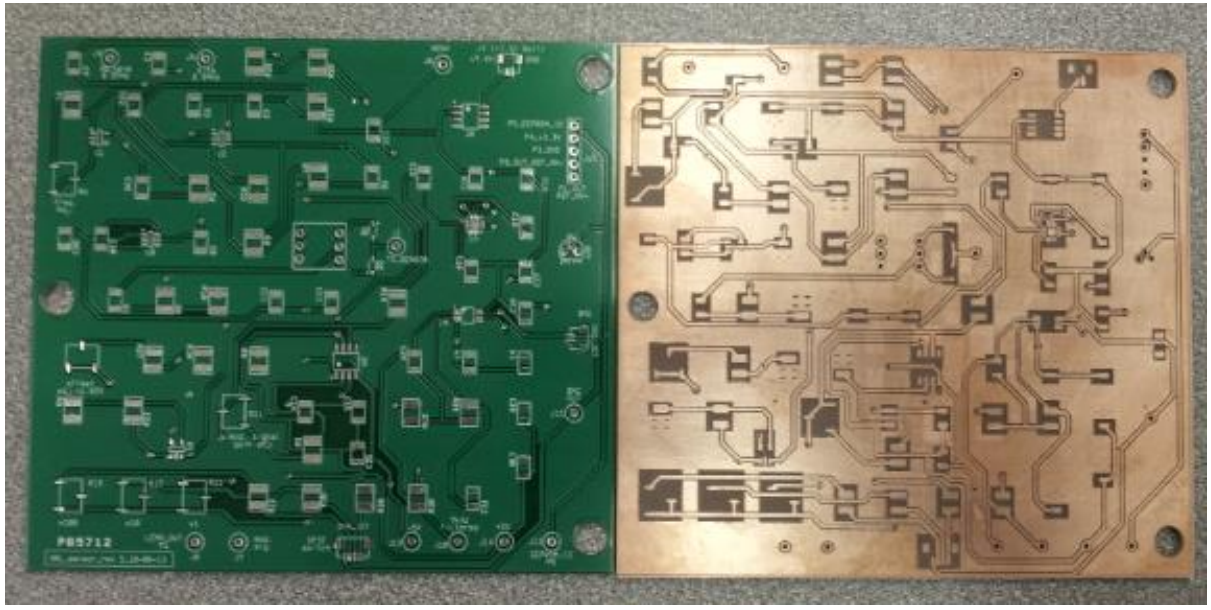
Terminology (Silkscreen & Soldermask)

- To make a board that can be assembled easily you need to have a silkscreen layer to indicate the placement of your parts



Soldermask expansion (a) and silkscreen (b)



Note having a naming convention for naming parts is crucial in a large PCB design

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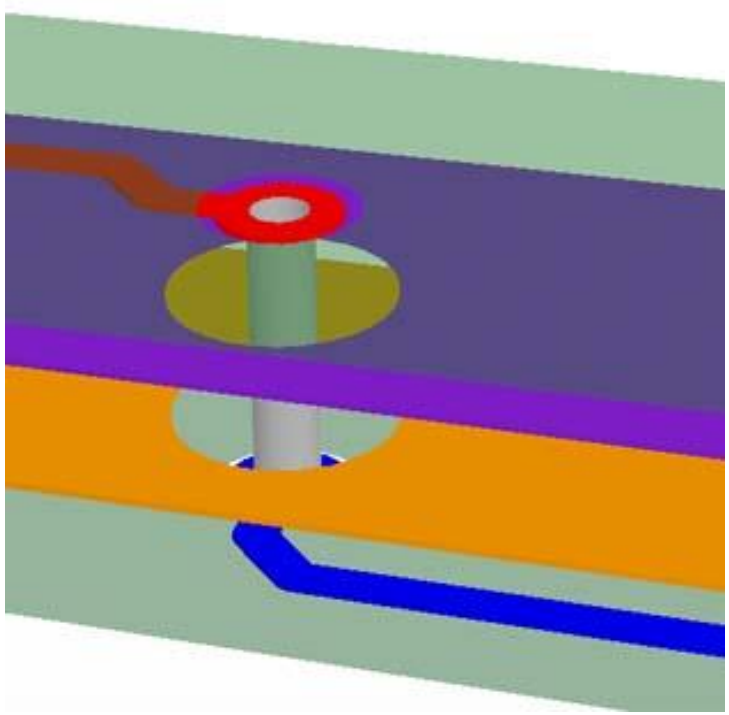
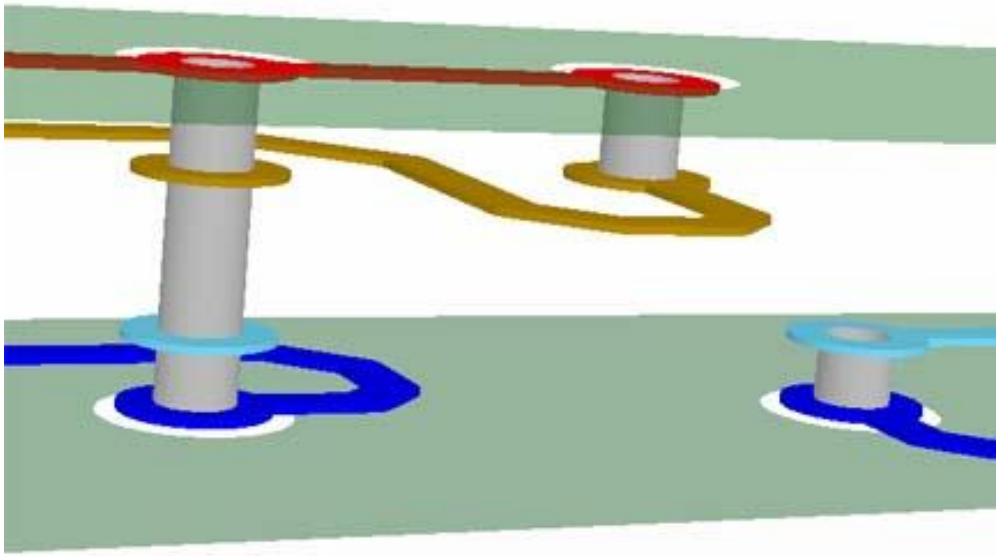
Terminology (Vias)

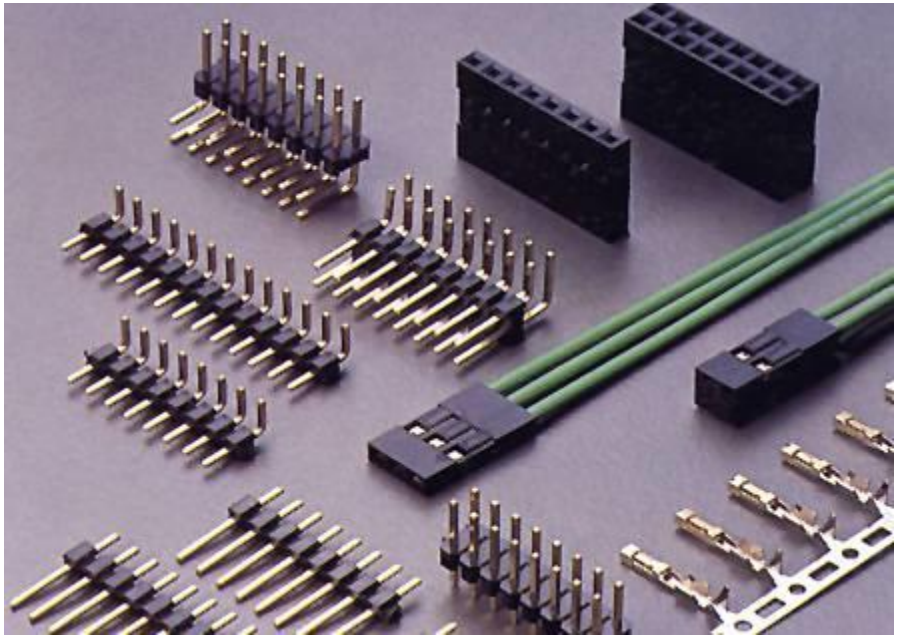
- Vias are used when you cannot make another trace and thus you need to use a via (we will be using one in the example board in our later demo)

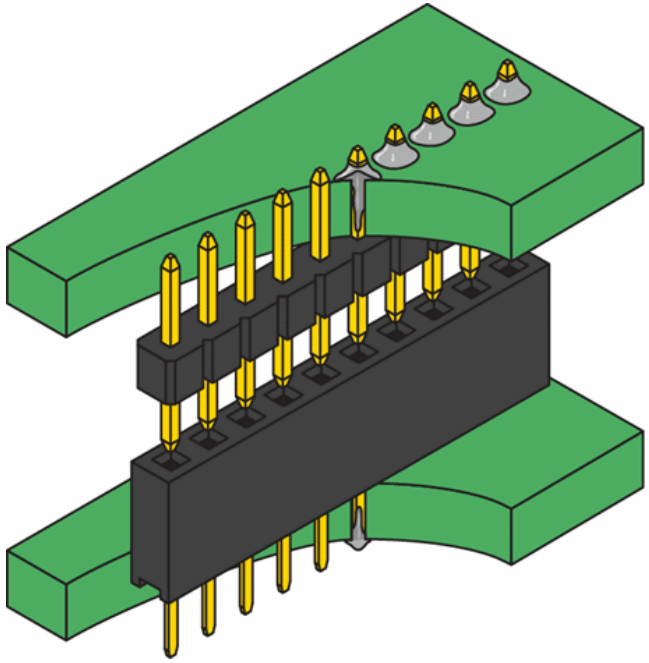




Terminology (Headers / Connectors)

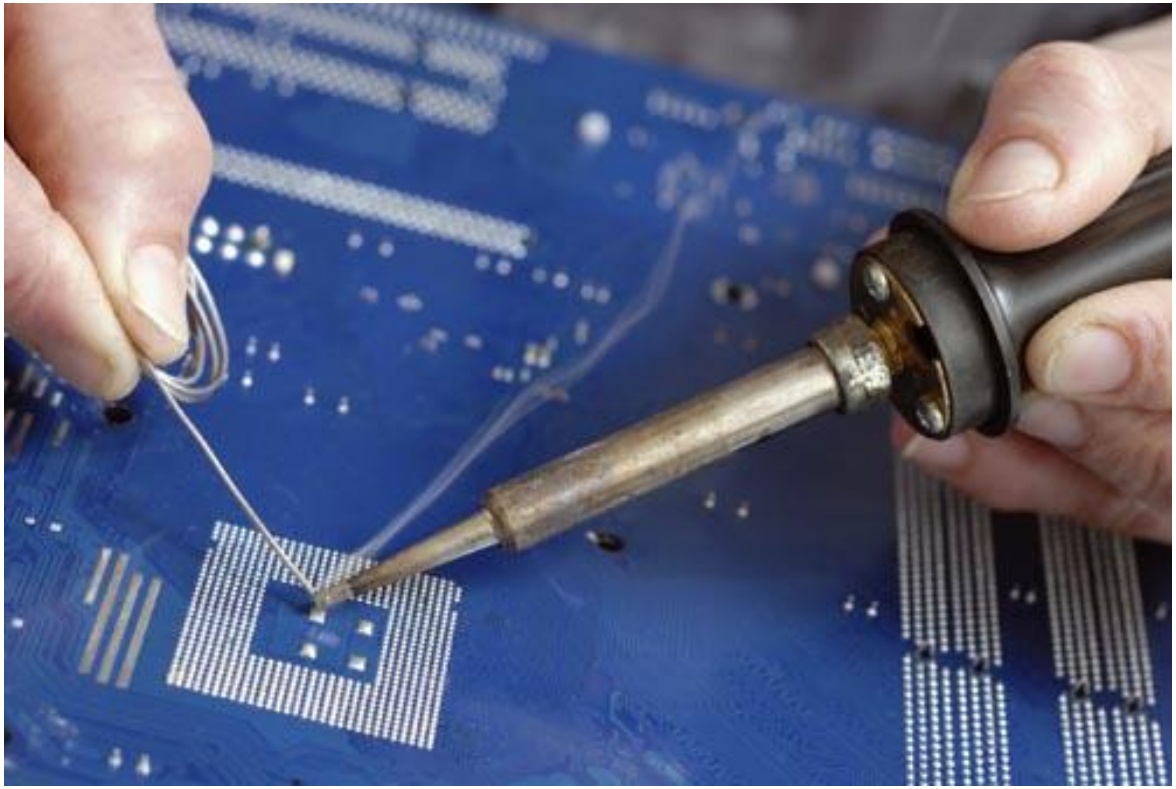
- For most applications you will need to interface your designed PCB with another PCB (called a Daughter Board) or some other peripheral device.





PCB Soldering Techniques (Hand Solder)

- Everyone should be familiar with this technique are you have just had a lab that required it. This is a common type of soldering for quick proof of concept builds that you want to make in house



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PCB Soldering Techniques (Wave Soldering)

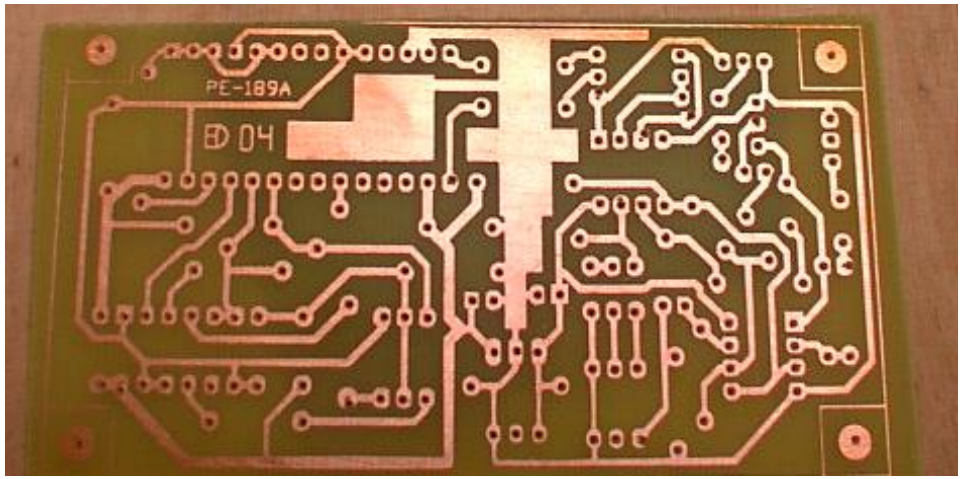
- Lets see a demo of this technique

http://www.pcadfacil.com.br/2009-12-Blog/

PCB Soldering Techniques (Etching)

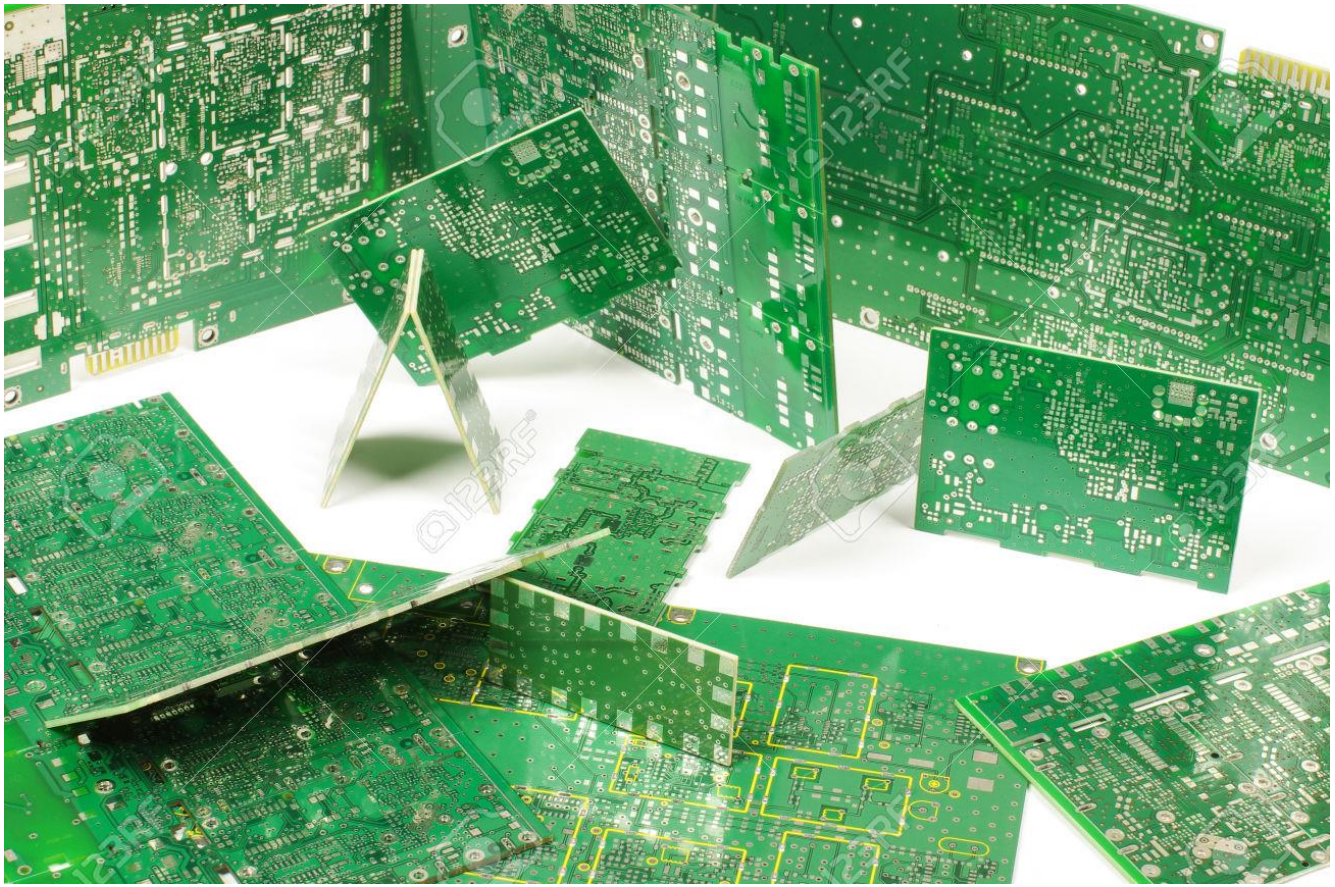
- A good technique for quick prototyping for proof of concept
- Downfalls is that you have to drill all holes and vias by hand
- Lets watch a quick video on this technique

https://www.youtube.com/watch?v=N3DGbwVXyN8



Design Considerations (Size)

- The size of the PCB will depend on your end application (Will it be fully embedded?)



Design Constraint (Power)

- After you have designed a PCB you need to consider how you will power your end device.
- Will it be connected to “The Grid” aka infite power or will you be placing the device in a remote location (i.e. finite power source aka A battery)

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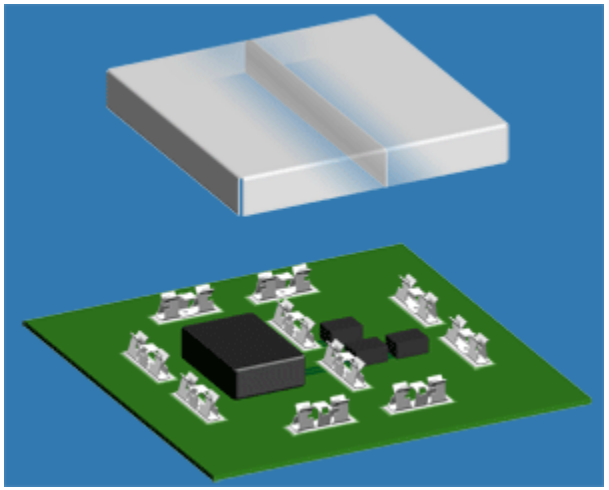
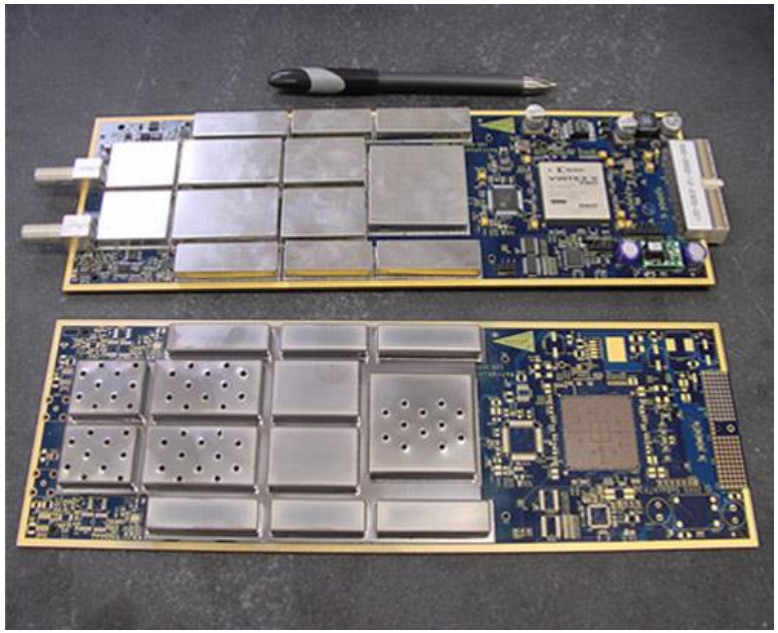
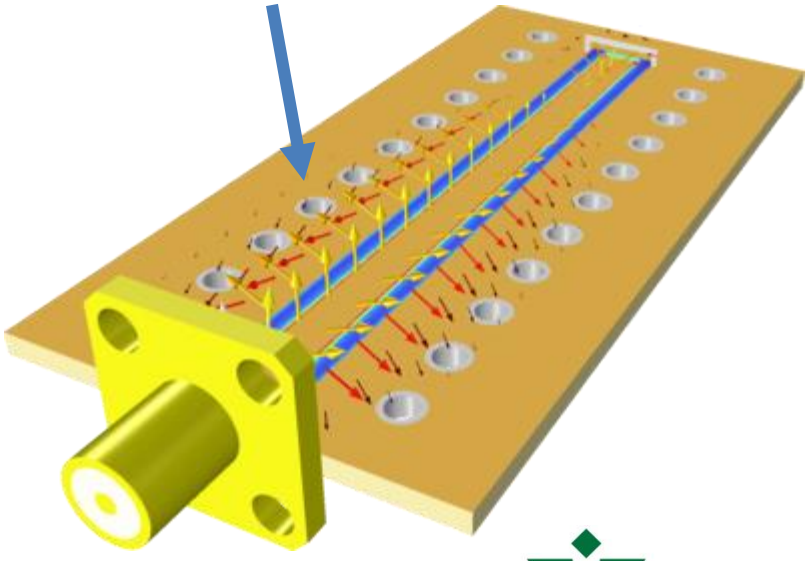
Design Consideration (RF shielding)

For high frequency applications you will need to employ a technique called shielding (and co-planer waveguides shown here with the SMA connector)





Co-Planer Waveguides



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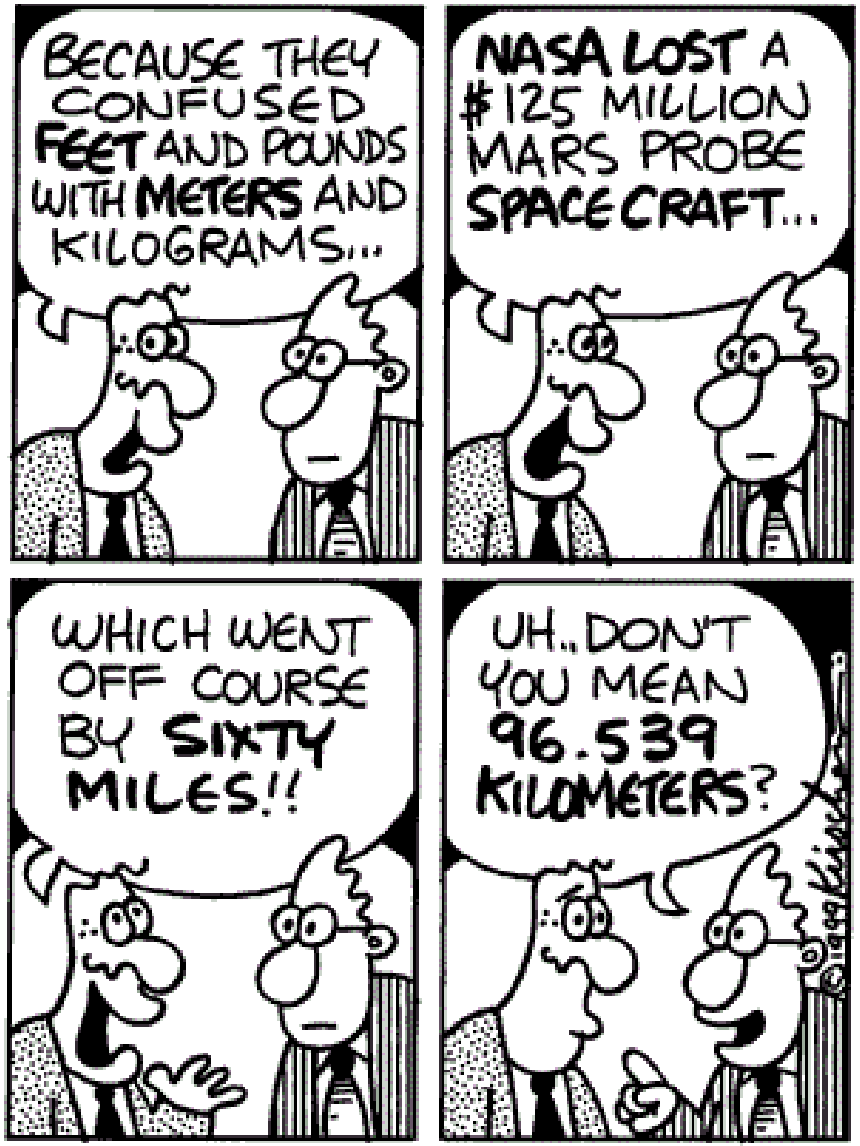
Pitfalls in PCB Design (Units)



- Ensuring that you are in the correct units is imperative in PCB design.
- All manufacturers use different standards for their parts
- Note this will also be designated in the mechanical drawing of the datasheet of any part that you desire to use

Pitfalls in PCB Design (Part Ordering / Backorder)

- To build a board you need to make sure the parts are available (not on backorder)

Product Index > RF/IF and RFID > RF Transceivers > NRF51822-QFAB-R7

All prices are in AUD. Change Currency

Digi-Key Part Number	1490-1032-1-ND
Quantity Available	Digi-Key Stock: 6,783 Can ship immediately
Manufacturer	Nordic Semiconductor ASA
Manufacturer Part Number	NRF51822-QFAB-R7
Description	IC SOC 2.4GHZ 128K FLASH 48QFN
Lead Free Status / RoHS Status	Lead free / RoHS Compliant

Price Break	Unit Price	Extended Price
1	4.88000	4.88
10	4.39300	43.93
25	3.98640	99.66
100	3.57970	357.97
250	3.25428	813.57
500	2.84752	1,423.76

Quantity: 5 | Item Number: 1490-1032-1-ND | Customer Reference: ANGUS | Add to Cart

Image shown is a representation only. Exact specifications should be obtained from the product data sheet.

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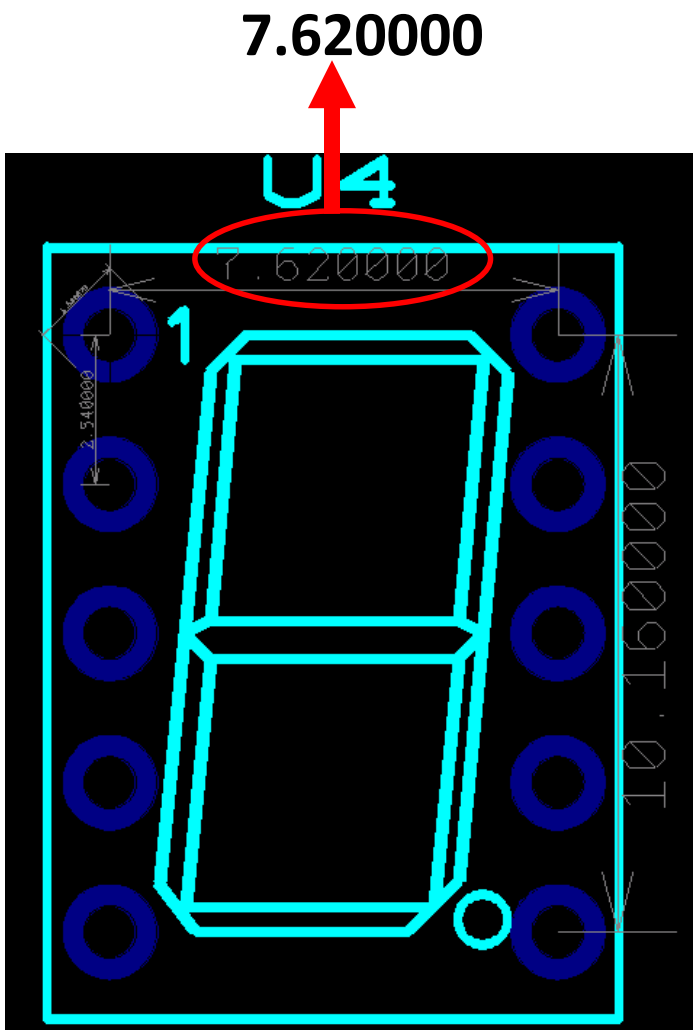
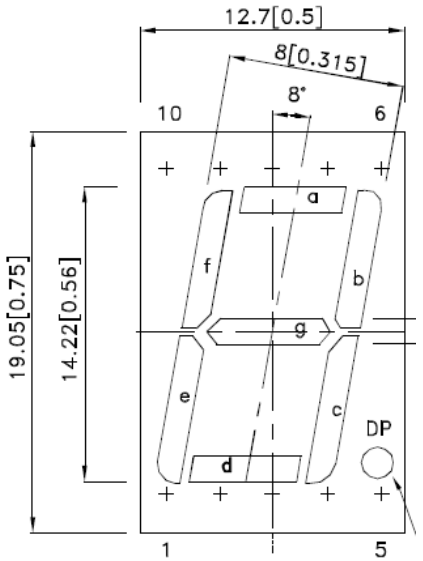
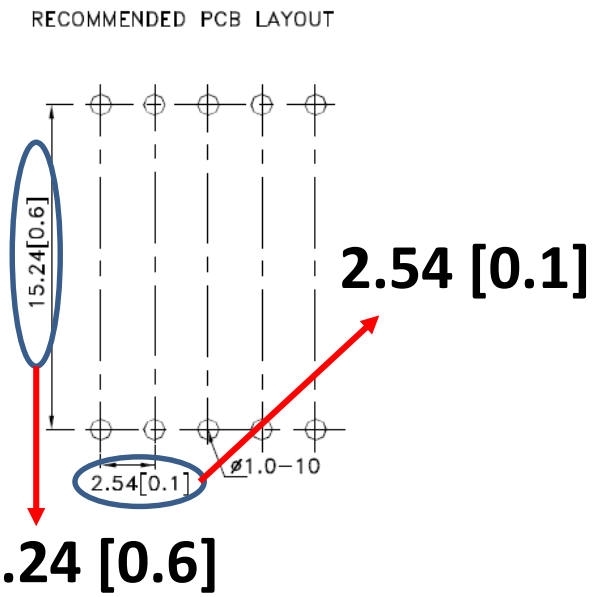
Pitfalls in PCB Design (Custom Footprints)







Q: Can you spot the problem?

A: The default footprint does not fit the desired part… thus we must make a custom part!

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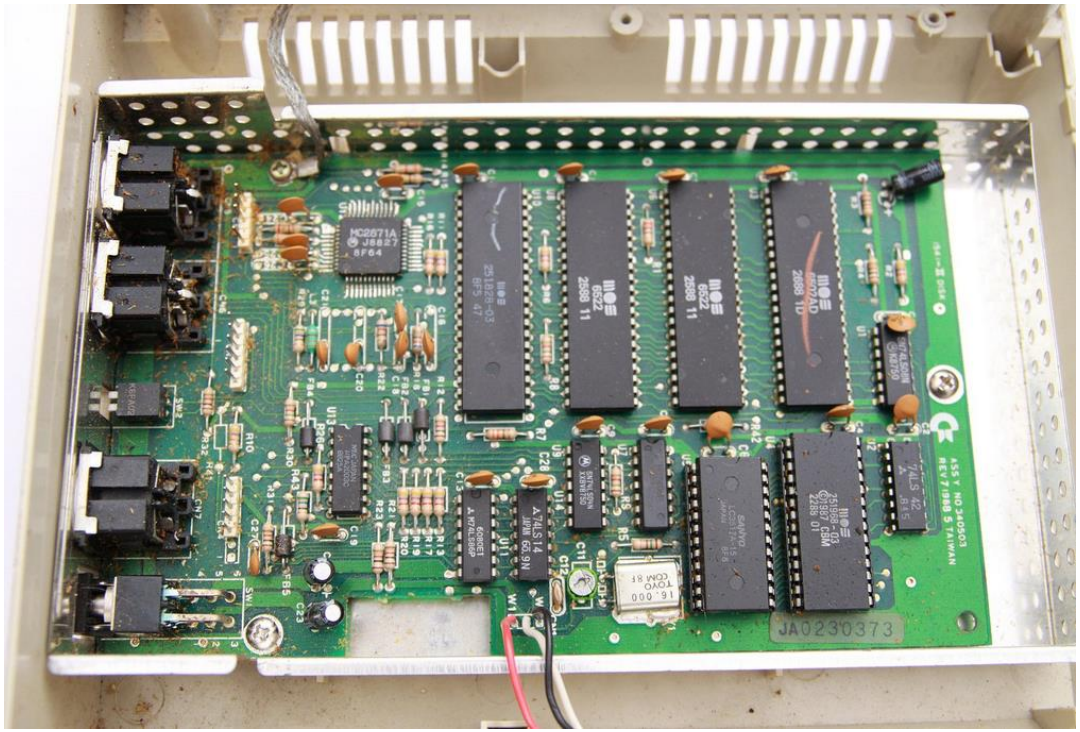
Design Constraint (Serviceability)

- Will you need to ever service the PCB that you have designed. (This decision is usually left up to the end user or the customer)



A Commodore 64 Logic Board from the late 1980's

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DEMO TIME!

Additional Resources

- **EEVBlog (Wild Aussie man but very good content!)**

  Here are three good videos he has on PCB design and manufacturing:

Part # 1 **Part # 2** **Part # 3** **His YouTube Channel**

- **A really good "Manual" on PCB design, terminology, and all around best practices… Here is the Link**

- **Here are some of the websites to the local manufactures that was discussed earlier in the presentation…**

- **M&M Technologies (Indian Trail, NC)**
- **GMI Manufacturing (Mooresville, NC)**
- **Micro Circuits Diversified (Salisbury, NC)**

References

Pictures

1. http://bytesdaily.blogspot.com/2015/07/funny-friday.html
2. https://upload.wikimedia.org/wikipedia/commons/8/86/Photo-SMDcapacitors.jpg
3. http://store.curiousinventor.com/guides/Surface_Mount_Soldering
4. https://c2.staticflickr.com/6/5172/5477287563_00fe802818_b.jpg
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16. http://chibi-sakura.org/images/smd_chart_v01.png
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19. https://bertsimonovich.files.wordpress.com/2013/04/image66.png
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21. http://www.electronicsandyou.com/blog/wp-content/uploads/2013/06/Hand-Soldering.jpg
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25. http://www.hackmelbourne.org/wiki/_media/doc:orders:digikey:addtocart.png
26. http://c8.alamy.com/comp/EJKGBM/pile-of-various-batteries-EJKGBM.jpg